Expropriation Risk Over the Business Cycle*

Hernán D. Seoane†
Universidad Carlos III de Madrid

Emircan Yurdagul‡
Universidad Carlos III de Madrid and CEPR

January 19, 2024

Abstract

Expropriation risks are key to understanding Emerging Economies' stylized facts and shape the business cycles of these countries. We model a benevolent government that chooses taxation without commitment and optimal debt issuance subject to sovereign default risk. Hence, our model introduces two types of expropriation risks in a standard open economy environment. These risks can explain the sovereign debt overhang effect that has been widely documented in the literature. Moreover, we show that the sovereign debt overhang, in turn, contributes to higher default risk leading to a vicious cycle of low investment and high sovereign default risk.

Keywords: Sovereign Default; Private Investment; Financial Frictions.

JEL Codes: E32; E44; F32; F34; F41.

*We thank Alberto Martín, Andy Neumeyer and Juan Pablo Nicolini for comments and suggestions, and the participants of the seminars at Universidad de Di Tella, Summer Meeting of the European Economic Association 2023, LACEA 2023, Spanish Macro Network 2023 and SAEe Simposio 2023. We thank MICIN/ AEI/10.13039/501100011033, grants CEX2021-001181-M, and Comunidad de Madrid, grants EPUC3M11 (V PRICIT) and H2019/HUM-5891 for financial support. Hernán Seoane thanks the AEI RYC2020-030507-I, and PID2019-107161GB-C31. Emircan Yurdagul gratefully acknowledges the grant IJC2018-038229-I by MCIN, grant 2020/00369/001 by AEI.

†Department of Economics, Universidad Carlos III de Madrid, Calle Madrid 126, 28903 Getafe, Madrid, Spain; E-mail address: hseoane@eco.uc3m.es

‡Department of Economics, Universidad Carlos III de Madrid, Calle Madrid 126, 28903 Getafe, Madrid, Spain; E-mail address: eyurdagu@eco.uc3m.es

1 Introduction

We develop a theory of expropriation risk over the business cycle in emerging economies. Our theory can rationalize several facts observed in economies prone to sovereign debt crisis: the low investment-to-output ratios, the excess investment volatility, and the sovereign debt overhang, i.e. the negative relationship between investment and sovereign debt, as outcomes of optimal taxation and sovereign debt management without commitment. Our framework allows us to disentangle the importance of two common forms of no-commitment in emerging economies. On the one hand, the model includes the optimal choice of sovereign debt and default that implies a confiscation of international investors. On the other hand, we introduce the optimal design of profit taxes under no commitment that implies a confiscation of domestic firms.

In line with the sovereign debt overhang effect, a phenomenon already documented in an extensive literature including Aguiar et al. (2009b), the data highlights the existence of non-trivial interactions between sovereign risks and private investment. First, Table 1 shows that the investment dynamics in countries that have defaulted in the past are different from those of non-defaulters. To show this we compute the investment-to-output ratio as well as the quarterly growth rate of real investment for the period 1980-2012. Using the table, we can highlight three facts: (1) defaulters have a lower average investment-to-output ratio, (2) investment in the case of defaulters grows less on average than for non-defaulters, and (3) investment growth is more volatile than in the case of non-defaulters.

[Insert Table 1 here.]

Second, the investment dynamics change sharply around the sovereign default episodes. Figure 1 shows that in the neighborhood of a sovereign debt crisis, investment (and the stock of capital) falls sharply. Investment drop starts as early as two years before a sovereign default, and it usually continues during the first couple of quarters after the default.

[Insert Figure 1 here.]

We model a small open economy populated by a benevolent government, a representative household, a continuum of firms, financial intermediaries, and international investors. Firms make investment decisions and produce the final good combining capital with intermediate inputs subject to a working capital constraint. The firms borrow the working capital through financial intermediaries that are subject to a financial friction. Households consume, own firms, and derive utility from government spending. International investors price sovereign debt. The government collects profit taxes, without commitment, and issues defaultable debt to finance government spending to maximize households' utility.

The frictional market for firms' debt generates an endogenous default cost as we assume that during default the financial access of firms becomes more limited than in normal times and the cost of funds increases. In a similar fashion to Mendoza and Yue (2012), default cost behaves endogenously in line with the exogenous output costs of Arellano (2008) that are asymmetric and induce default in bad times.[1]

We find a non-trivial interaction between sovereign default risk and profit taxation. Tax rates and spreads are positively correlated, especially during the build-up of a sovereign debt crisis. In a context of increasing spreads the government's objective is to distribute the fiscal burden in the two distortions arising from the lack of commitment. Too fast an increase in the stock of debt pressures spreads up increasing the expected cost of funding of firms. On the other hand, facing the increasing fiscal burden using corporate taxes reduces capital accumulation incentives and the returns to capital, also pressuring up spreads due to the perception of international investors. Hence, the government

[1] Mendoza and Yue (2012) assumes that during default, the economy as a whole loses access to international financial markets and firms cannot purchase imported intermediate inputs as they cannot raise working capital. Instead, we assume that during default the financial conditions worsen and the firms can still borrow from international investors, a milder assumption that is also in line with the historical evidence as during sovereign defaults firms do not fully lose access to international financial markets.

approaches a sovereign default balancing these two effects, which explains the positive correlation between tax rates and spreads. Empirical evidence suggest that as when the economies are in a debt crisis, they are more prone to introduce new taxes which increase the effective tax rate faced by firms.[2]

This dynamic explains the sovereign debt overhang effect. When the government accumulates large levels of debt and enters into a debt crisis, the domestic private sector will eventually suffer from higher taxes or higher funding costs in the case of default. The expected return to capital decreases, reducing investment and the stock of capital. At default, spreads remain high but taxes and government spending decrease: default is a source of funding that expropriates foreign investors and relaxes confiscation through taxation.

Next, we isolate the effects of each source of no-commitment. First, we fix the tax rate but allow for optimal debt management and default. In the economy without tax commitment, investment is 10% smaller compared to the fixed tax case and volatility is twice as large. Hence, the lack of tax commitment helps explain the low investment ratios and its excess volatility. Second, optimal taxes affect the government spending procyclicality: the government will increase taxes and spending in goods times when the distorting effect is smaller, however, overall no-commitment reduces average spending. Finally, optimal taxes increase both the level and the countercyclicality of spreads. The reason is that when taxes are fixed, the government would like to further avoid default and hence will issue on average less debt and default less often as it cannot use a fiscal instrument once in default.

If, instead, we remove the default option, the government sustains larger levels of debt but both the average tax and the volatility of taxes increase. In bad times, in the context of a debt crisis, the government does not default but will need to raise resources only using

[2]For instance, during the build-up of the sovereign default in Argentina in 2001/2, the government introduced new taxes, such as the "Minimum presumed income tax" (1998) and the "Check tax" (2001).

taxes: taxes are more countercyclical. Investment, as a consequence, becomes also more volatile but compared to the baseline the economy accumulates more capital because it is not subject to the tail risk of default.

Our paper relates to two branches of the international macro literature that, even though study similar questions, use different modeling choices. First, we relate closely to Aguiar et al. (2009a), Aguiar et al. (2009b) and Aguiar and Amador (2011). In these papers, the authors extend the Neoclassical Growth Model with political frictions and no commitment to study the expropriation dynamics of foreign capital. As opposed to these papers, we study optimal taxation and default incentives when default happens in equilibrium and investment is domestic, that is, there is a trade-off between defaulting with certain costs or expropriating the domestic private sector.

Second, this paper also relates to the literature of strategic sovereign default after the seminal work of Eaton and Gersovitz (1981). The vast majority of the studies that belong to this literature assume endowment economies. Mendoza and Yue (2012) introduces an environment with endogenous output and endogenous costs of default. Since then some papers have departed from the endowment economy assumption and included production, mostly assuming that firms combine intermediate inputs with labor. Bai and Zhang (2012), Gordon and Guerron-Quintana (2018) and Park (2017) are the first ones to introduce capital accumulation in the default environment of Arellano (2008). Bai and Zhang (2012) and Gordon and Guerron-Quintana (2018) assume endogenous production of a unique good that the household can use for consumption or investment. In these papers, there is a motive for the government to accumulate capital to improve the borrowing conditions.[3] However, in all of these papers, the capital accumulation decision is centralized. That is, the benefit of capital accumulation is fully internalized by the planner that decides debt issuance and default decisions.

[3]Similarly, Bianchi et al. (2018) study the foreign reserves, instead of capital, as an instrument that is optimally accumulated by the government to study its role as a signal right incentives to repay the debt.

A few papers have studied the decentralized investment choice besides ours in the context of sovereign risk. Among them the papers that are closer to ours are Arellano et al. (2017), Esquivel (2022), Galli (2021) and Chaumont et al. (2023). These papers, however, do not study how the interplay of default and optimal taxes affect investment and the business cycle. In turn, the objective of this paper is to study how optimal taxation without commitment interacts with foreign debt expropriation over the business cycle, its impact on investment, and how this feeds back to sovereign spreads.

Our paper also relates to the study of fiscal policy with default risk. As in Gonçalves and Guimaraes (2015) and Liu and Shen (2022) we have a time inconsistency problem. However, there is a key difference. The time inconsistency problem in their environment comes from the fact that the government issues debt before taxation, hence the government has an incentive to promise high taxes to face a low spread but after debt is issued, it has an incentive to lower taxes. In contrast, our government decides both taxes and debt issuance at the same time and hence does not suffer from this type of time inconsistency. Instead, there is a time inconsistency regarding capital accumulation given that the government has incentives to increase taxes today as capital was invested a period before. There is an incentive to confiscate domestic capitalists, together with an incentive to default on international investors. We also relate to Cuadra et al. (2010) that analyses the role of fiscal procyclicality in the context of countercyclical default risk, however, they abstract from capital accumulation and investment decisions.

The remainder of the paper goes as follows. In Section 2 we introduce the setup of the benchmark model. Section 3 presents the calibration details for the numerical implementation of the model. Section 4 discusses the quantitative implications of expropriation risk. Section 5 provides some robustness analysis. Section 6 concludes.

2 The model

We build a sovereign default model for a small open economy in the tradition of Eaton and Gersovitz (1981) and Arellano (2008). The economy is populated by firms, households, and the government. The government has direct access to international financial markets and issues defaultable debt. Firms produce a final good using capital and imported inputs which are subject to a working capital constraint that they borrow from international investors through a competitive market of frictional financial intermediaries. As standard in the literature, international investors are risk-neutral agents that break even in expectation.

2.1 The households

Households derive utility separately from the consumption of private and public goods. As owners of firms, the households receive corporate profits in a lump sum fashion and use them to finance their private consumption. Households do not have access to financial markets and all international borrowing is done by financial intermediaries and the government. Their present discounted value of lifetime utility is represented by

$$\sum_{t=0}^{\infty} \beta^t \left[u(c_t) + v(g_t) \right],$$

where c_t and g_t denote private consumption and the public good received by the households, respectively. Standard assumptions about $u(\cdot)$ and $v(\cdot)$ apply.

2.2 The corporate sector

We model a continuum of firms with a unit mass. Households are the shareholders of the firms and we assume that the firms do not issue new shares. Firms own the stock of capital, k, import intermediary production goods and produce the final good. The unit price of intermediate goods is exogenously given at $\bar{p}$, and the firms need to pay for the intermediate inputs in advance before production takes place. They need to borrow from a financial intermediary to finance the acquisition of a fraction Θ of these goods, and they are charged an endogenous interest rate r for the intra-period borrowing.

Firms discount the future with the stochastic discount factor of the households, denoted by M', and maximize the present discounted value of profits. Firms make their decisions after the government makes its, taking as given the choices of the government for debt, b', default, d', and profit tax, τ, as well as the current states of aggregate productivity, z, individual capital, k, and aggregate capital, $\bar{k}$. Accordingly, the value of a firm at the beginning of the period is:

$$V^f(z,k,\bar{k};\tau,b',d') = \max_{k',x} (1-\tau)\Pi + (1-\delta)k - k' - C(k',\bar{k}) + \mathbb{E}_{z'|z} M' V^f(z',k',\bar{k}';\tau',b'',d'')$$

$$\begin{aligned}
\text{s.t.} \quad & \Pi = zk^\alpha x^\eta - \bar{p}x(\Theta r(z,\bar{k},d') + 1) \\
& \bar{k}' = k^*(z,\bar{k},b',d') \\
& b'' = \tilde{b}(z',\bar{k}',b',d') \\
& d'' = \tilde{d}(z',\bar{k}',b',d') \\
& \tau' = \tilde{T}(z',\bar{k}',b',d'). \\
& M' = \beta \frac{u'(c^*(z',\bar{k}',\tau',b'',d''))}{u'(c^*(z,\bar{k},\tau,b',d'))}
\end{aligned}$$

Here, $r(z,\bar{k},d')$ is the real net interest rate on corporate, intra-period loans. This rate is an equilibrium object that depends on the demand for credit, which is a function of aggregate capital and productivity, as well as the supply, which depends on whether the government is in default or not. The flow value of the firm is the after-tax firm profits net of current investment costs. The continuation value of the firm is $E_{z'|z}M'V^f(z',k',\bar{k}';\tau,b',d')$, which entails the stochastic discount factor M' as the ratio of the future marginal utility of private consumption to the current one.

In our setup, the optimization for intermediate inputs only depends on productivity, individual and aggregate capital, and the default status. In particular, the optimal choice is given by:

$$\tilde{x}(z, k, \bar{k}; d') = \left(\frac{\eta z k^{\alpha}}{\bar{p}(1 + \Theta r(z, \bar{k}, d'))} \right)^{\frac{1}{1-\eta}}.$$

Meanwhile, by making the adjustment costs only depend on the current aggregate capital (and not current individual capital) and individual capital choice, we have the property that the investment decisions do not depend on the current firm-level capital stock. The envelope and the first order conditions give the optimality condition for the capital decision:

$$1 + C_1(k', \bar{k}) = E_{z'|z} M' \left[\alpha \left(\frac{\eta}{\bar{p}(\Theta r(z', \bar{k}', d'') + 1)} \right)^{\frac{\eta}{1-\eta}} (1 - \tau') z'^{\frac{1}{1-\eta}} k'^{\frac{\alpha}{1-\eta} - 1} + 1 - \delta \right],$$

which states the standard result that the marginal cost of capital including the adjustment costs, in the optimum, equals the present value of the marginal return.

We denote the policy function of a firm for capital accumulation with $\tilde{k}(z, \bar{k}; b', d')$. The consistency for the evolution of aggregate capital, as well as the aggregate intermediate input demand, requires that:

$$k^*(z, \bar{k}; b', d') = \tilde{k}(z, \bar{k}; b', d'),$$

and

$$x^*(z, \bar{k}, d') = \tilde{x}(z, \bar{k}, \bar{k}, d').$$

The firms' choices determine the demand for intermediary inputs. The supply of these funds is provided by a set of financial intermediaries, which we defer to the end of the model description.

2.3 The government

The government issues foreign debt without commitment in order to maximize households' welfare. If it starts the period in good credit standing, it chooses whether to pay its debt to potentially issue new debt, or default. In case of default, the country enters into autarky for a random number of periods during which it does not need to make a debt payment. When the autarky ends, the country recovers good credit standing with a debt stock that is trimmed by a haircut of ψ.

Formally, if the sovereign starts the period out of default with a debt level b, aggregate capital $\bar{k}$, and productivity z, then its value is:

$$V(z,\bar{k},b) = \max\{V^C(z,\bar{k},b), V^D(z,\bar{k},b)\}.$$

The value for the case of repayment is:

$$V^C(z,\bar{k},b) = \max_{g,b',\tau}\ u(c) + v(g) + \beta E_{z'|z}\Big[V(z',\bar{k}',b')\Big]$$

subject to

$$g = q(z,\bar{k}',b')b' - b + \tau\left(zf(\bar{k},x) - \bar{p}x(\Theta r(z,\bar{k},0)+1)\right)$$

$$c = (1-\tau)\left(zf(\bar{k},x) - \bar{p}x(\Theta r(z,\bar{k},0)+1)\right) - \bar{k}' + \bar{k}(1-\delta) - C(\bar{k}',\bar{k})$$

$$\bar{k}' = k^*(z,\bar{k};b',0)$$

$$x = x^*(z,\bar{k},0).$$

Here, $q(z,\bar{k},b')$ denotes the unit price of issued debt that promises to repay one unit in the following period. The first constraint is the budget constraint of the government, the second is the balance of payments and the third equation states that the government optimizes conditional to the competitive response of the corporate sector. Note that the last arguments in functions r, k^*, and x correspond to the default decision of the government in the current period which is equal to $d' = 0$ for the repayment case. Instead, the value when the government is in default, its value is:

$$V^D(z, \bar{k}, b) = \max_{g,\tau} \; u(c) + v(g) + \beta E_{z'|z}\Big[\theta V(z', \bar{k}', (1-\psi)b) + (1-\theta)V^D(z', \bar{k}', b)\Big]$$

subject to

$$g = \tau \left(zf(\bar{k}, x) - \bar{p}x(\Theta r(z, \bar{k}, 1) + 1)\right)$$

$$c = (1-\tau)\left(zf(\bar{k}, x) - \bar{p}x(\Theta r(z, \bar{k}, 1) + 1)\right) - \bar{k}' + \bar{k}(1-\delta) - C(\bar{k}', \bar{k})$$

$$\bar{k}' = k^*(z, \bar{k}; b', 1)$$

$$x = x^*(z, \bar{k}, 1),$$

where θ captures the probability of re-entry into financial markets each period. When the government is in default, the financial conditions of the corporate sector deteriorate. We denote the policy functions of the government for optimal debt as $\tilde{b}(z, \bar{k}, b)$, for default as $\tilde{d}(z, \bar{k}, b)$ and for profit tax as $\tilde{T}(z, \bar{k}, b, d)$.

Note that the government faces two problems of time inconsistency. First, it cannot commit to repaying the debt to international investors, a usual assumption in this literature. On top of this, given that capital used in production in period t has been decided in period $t-1$, the government has incentives to tax current firms' profits. The two types of time inconsistency interact in a non-trivial way. Unexpected increases in taxes, reduce the amount of debt and hence affects negatively the sovereign spread. On the other hand, when sovereign spreads are large, this puts fiscal pressure on taxes, which may crowd out investment and affect the pricing of sovereign debt.

The pricing of debt is standard. There is a continuum of risk-neutral lenders that are subject to the international risk-free rate of r^*, and incorporate in the bond price the probability of default. The zero-profit condition for the debt in good standing is:

$$q(z,\bar{k}',b') = \frac{1}{1+r^*}\mathbb{E}\left\{1 - \mathbb{I}(\tilde{d}(z',\bar{k}',b')=0) + \mathbb{I}(\tilde{d}(z',\bar{k}',b')=1)q^D(z',\bar{k}'',b')\right\},$$

where $\bar{k}'' = k^*(z',\bar{k}';b',1)$. The same condition for the debt in default is:

$$q^D(z,\bar{k}',b') = \theta(1-\psi)q(z,\bar{k}',(1-\psi)b') + \frac{1-\theta}{1+r^*}\mathbb{E}\left\{q^D(z',\bar{k}'',b')\right\}.$$

2.4 The financial intermediaries

The firms access international financial markets through a continuum of perfectly competitive financial intermediaries. We borrow the frictional environment of the financial intermediaries from Gabaix and Maggiori (2015) and Davis et al. (2023) where intermediaries are subject to a participation constraint as they can abscond resources borrowed internationally. Nevertheless, we depart from these authors in the functional form of the participation constraint and the intuition of the underlying financial friction.

These intermediaries live for only one period and maximize profits (W). They borrow Q in international markets, at a risk-free rate, and use the borrowed funds to provide intra-period loans to domestic firms, at the intra-period rate $r(z,\bar{k},d')$. We assume there is a piecewise constraint to operate the credit technology:

$$G(Q,\Gamma(d)) = \begin{cases} \Gamma(d)Q^2, & \text{if } \Gamma(d)Q^2 < \Gamma_{\text{max}}Q \\ \infty, & \text{otherwise.} \end{cases}$$

This constraint captures that the intermediary requires profits to be at least a fraction $\Gamma(d)Q$ of the loan. This is a participation constraint. The upper bound, $\Gamma_{\text{max}}Q$, implies that the intermediaries cannot take too long positions in the corporate sector of an emerging market, we interpret this as a statutory requirement.

The asking profits increase more than proportionally with the quantity of lending and become prohibitively large if the quantity exceeds a critical limit. These frictions overall capture in reduced form the risks associated with operating in emerging markets, which increase with the size of the operation. We assume that the minimum level of profits needed to operate increases when the country is in default i.e. $\Gamma(d=1) > \Gamma(d=0)$. This implies a deterioration of the financial markets in default that is consistent with increases in corporate interest rates, as observed in the data.[4]

The financial intermediaries' optimization problem is to maximize

$$W = \max_{Q \geq 0} \left(r(z, \bar{k}, d') - r^* \right) Q,$$

subject to

$$G(Q, \Gamma(d)) \leq \left(r(z, \bar{k}, d') - r^* \right) Q$$

For any for any $r(z, \bar{k}, d') > r^*$, the participation constraint will bind, which gives,

$$Q = \frac{1}{\Gamma(d)} \min\{r(z, \bar{k}, d') - r^*, \Gamma_{\text{max}}.\}.$$

In equilibrium, the intermediaries borrow in the market $Q = \bar{p}\Theta x^*(z, \bar{k}, d')$. Hence, the last equation determines the net private interest rate, r.

Graphically, we can represent the equilibrium in the loan market as shown in Figure 2.

[Insert Figure 2 here.]

Figure 2 represents the partial equilibrium in the private credit market in normal times and in default. The dashed lines represent the credit demand functions for low TFP

[4] Another option is to assume that Γ(def. prob.). This alternative assumption would increase slightly the correlation between private and sovereign spreads but overall will not generate strong quantitative differences to the current setup. The reason is that when the economy approaches a default episode, demand for intermediate inputs is low regardless of the financial constraint.

$x(z_L, ...)$ and high TFP $x(z_H, ...)$. A higher realization of the TFP implies a higher demand for intermediary inputs at all rates, hence, shifts up the demand for loans. The solid black line (that crosses points B and D) is the supply of credit when the economy is in default and the steeper dotted line (that crosses points A and C) is the supply of credit in normal times.[5] Notice that while the private interest rate is below the risk-free rate the financial intermediaries' supply of funds is zero as intermediaries would incur losses. Starting at $r = r^*$, the supply of loans is increasing until the upper bound. In this increasing region, the participation constraints are binding in and out of the default. Each of these supply curves, flattens at the level where the fraction $\Gamma(d) \times Q$ hits the upper bound, $\Gamma_{\max}$.

The figure illustrates the endogenous default costs implied by the tighter frictions in default, $\Gamma(d = 1) > \Gamma(d = 0)$. In case of low productivity, z_L, the government default moves the equilibrium from point A to B, where the quantity of lending supplied to firms is lower and the interest rate is higher. In case of high productivity, $z_H > z_L$, the comparable move in the equilibrium would have been from points C to C′, which would imply a roughly proportional decrease in the lending quantity. However, due to the second constraint, the actual drop is to point D, which is further down than point C′.

Ultimately, the effects of default on the equilibrium quantity of private lending are more severe when productivity is higher. The $\Gamma_{\max}$ constraint makes the endogenous default cost increase more steeply with productivity. This convexity of the default costs renders counter-cyclical default probabilities and public debt spreads as in the data. Moreover, by generating and endogenous link between default costs and TFP, they make the default more random and allow the model to reconcile non-degenerate debt and default models.

[5]Note that the dotted line and the solid black lines coincide over the region below the one indicated by $\Gamma_{\max}/\Gamma$.

Empirical plausibility of the financial channel

The financial channel plays a key role in our model as it defines the endogenous default costs. Figure 3 presents the evolution of corporate debt and interest rates around the 2001 default in Argentina.

[Insert Figure 3 here.]

The figure shows that during the 2001 default, besides the common stylized facts observed for the business cycles in emerging economies that show that output, investment, private consumption and government consumption fall around the default episode, the corporate external borrowing (measured in USD) falls too, an indicator that financial conditions for the private sector worsen while the private interest rate and the sovereign spreads increase. The figure shows that there is a close correlation between the sovereign interest rates (blue solid line) and the private lending rates (black dotted line). Outside the default environment, the rates' comovement is strong. The patterns in default differ slightly given that private rates are mostly affected by business conditions and sovereign rates are affected by a political renegotiation process. This comovement, particularly the jump in corporate rates when the sovereign defaults, provides empirical support for the transmission to the corporate debt markets.

The increase in the rates around default and the drop in corporate borrowing will be consistent with, and it motivates, our model for corporate borrowing. Note, additionally, that the comovement between corporate rates and corporate debt points to a supply-driven credit crunch, in line with our financial friction. Firms are not able to roll over existing debts and are forced to deleverage, reflected by the increase in corporate interest rates and a fall in corporate debt. If instead, the friction operates on the demand side assuming that the supply does not change we should observe a fall in loans with a lower corporate interest rate.

3 Calibration and functional forms

For quantitative evaluation, we assume functional forms that are standard in the business cycles and the sovereign default literature. The production features decreasing returns, and it depends on capital, imported inputs, and an aggregate productivity shock:

$$y = zf(k, x) = zk^{\alpha}x^{\eta}.$$

The exogenous productivity follows an AR(1) process. Households' preferences for private and public goods are both represented in CRRA form as

$$u(c) = \frac{c^{1-\gamma}}{1-\gamma}, \quad \text{and} \quad v(g) = \nu\frac{g^{1-\mu}}{1-\mu},$$

respectively, where we assume that private and public consumption are separable.

The capital accumulation technology has convex adjustment costs to prevent counterfactual current account volatility,

$$C(k', \bar{k}) = \kappa\bar{k}\left(\frac{k'}{\bar{k}} - 1\right)^2.$$

We calibrate our model to the Argentinean economy. We fix some parameters following the existing literature and calibrate the remaining parameters to match some most relevant first and second-order moments in the data. Panel A in Table 2 presents the parameter values calibrated following the literature. The CRRA coefficients on private good consumption, γ, are set to 2, households' discount factor β is set to 0.96, and the quarterly depreciation rate of capital is 2%. Following Arellano (2008), we set the quarterly risk-free rate to 1.7%, and the probability of leaving autarky post-default in each quarter, θ, to 0.282. The capital share is set to 0.17 and the share of intermediate inputs to 0.43 following Mendoza and Yue (2012). We calibrate the exogenous haircut rate after default, ψ, following the averages computed in Dvorkin et al. (2021) for the emerging markets since 1970. Additionally, we set $\Theta = 1$ and $\bar{p} = 1$, which means that the firms need to finance all the purchases of intermediate goods through borrowing and that the price of these inputs is equal to that of the consumption good.

[Insert Table 2 here.]

Panel B of Table 2 presents the parameters that are calibrated to match the targets in Table 3. We target Argentina's data for the period 1992 to 2019, at quarterly frequency. κ determines the adjustment cost of capital and has a direct impact on the variation of investment, and its comovement with other macro indicators. Accordingly, we target the ratio of investment volatility to output volatility. As in Kaas et al. (2020), we calibrate the weight of public good in household preferences, ν, and the curvature in the utility function for public good, μ, to match the average government spending to output ratio and the volatility of the public expenditure relative to output, respectively. We set the parameters of the aggregate productivity process, ρ_z and σ_z, to match the persistence and volatility of the HP-filtered log-output.

Productivity losses in default arise endogenously from the interaction between firms and financial intermediaries. Three parameters govern these frictions in our model. The fraction that the financial intermediaries can abscond in regular times, $\Gamma_L Q$, is determined by Γ_L. This fraction post-default, $\Gamma_H Q$, is governed by $\Gamma_H > \Gamma_L$, and the limit $\Gamma_{\max}$. All else equal, the difference between Γ_L and Γ_H increases the default costs. Meanwhile, as we described in Section 2.4, the level of $\Gamma_{\max}$ governs the cyclicality of the default costs. The randomness in the default events implied by this cyclicality increases the default rates by making default less avoidable. With all these mechanisms in mind, we calibrate Γ_L to match the average corporate spreads, Γ_H to match the drop in output one quarter after default, and $\Gamma_{\max}$ to generate an annual default rate of 2% percent. Table 3 shows the model fit to the targeted moments.

[Insert Table 3 here.]

We solve the model by introducing taste shocks to the government's portfolio decisions as described in Dvorkin et al. (2021). In particular, in each period the government receives a vector of taste shocks for each discrete choice (debt level and default), drawn independently over time. By making the sovereign policy functions for debt and default probability density functions rather than discrete functions, these shocks smooth out the value functions of the government and the price function of its bonds. Ultimately, they facilitate the convergence of the model solution. These shocks are small and meant to serve only as a solution technique without changes in the economic outcomes of first-order importance. We describe the details of this method in Appendix A.1.

4 Results

Table 4 presents some non-targeted moments. The model captures well the correlations of public and private expenditure with output observed in the data. It exhibits procyclical government spending, the countercyclical trade balance to output ratio, and the lack of consumption smoothing, the most salient facts of emerging economies. In line with this, the sovereign spreads feature a negative correlation with output as well as with public expenditure, as in the data. In a nutshell, our economy appropriately reflects the comovement observed in the data for the key variables of our theory.

[Insert Table 4 here.]

Figure 4 computes the correlation between log investment and leads and lags of EMBIG in the data for six emerging economies and compares them with the correlation implied by the model (the thick solid line). The model captures the negative correlation between these variables and the fact that this correlation is less negative with higher leads and lags. Two features of the model are behind these correlations: the increasing cost of external finances for the firm in default, and the fact that crises happen after a sequence of bad TFP realizations that also reduce the return to capital, and increase public sector spreads. Current investment is also negatively correlated with future spreads, suggesting a role for private investment in the foreign debt market of the government. We show below that the price of debt is increasing in the stock of capital. Hence, the model captures the feedback effects between spreads and investment.

[Insert Figure 4 here.]

Expropriation and the business cycle

The government in our model is time-inconsistent. First, it is optimal for the government to promise to repay its debt but at maturity, the government may default. Second, the government decides profit taxes once the stock of capital is fixed, hence it has incentives to deviate from any promised tax. The domestic agents and international investors understand these facts and adapt their behavior. We study here how time inconsistency shapes the business cycle in this model.

Table 5 characterizes the dynamics of investment in the baseline model and three counterfactual economies: an economy with fixed profit taxes that eliminates the time-inconsistent tax behavior, an economy with large utility costs of default that reduces the default rate to an almost nil frequency, and, an economy with both fixed taxes and large utility costs of default.[6]

[Insert Table 5 here.]

The first block of the table highlights some interaction between the two sources of confiscation. The first two columns show that fixing the tax rate substantially reduces the

[6]In the economies with fixed taxes, we set the profit tax rate τ to the benchmark mean of 15 percent. In those with the utility costs of default, we subtract a constant $\bar{U} = 0.5$ from the utility of the household whenever the economy is in default (i.e. autarky).

default rate. There is a complementarity in these two ways to expropriate the private sector. The price of debt increases and the average debt decreases in terms of output which suggests that the government wants to avoid default. The reason is that as taxes are fixed, the government cannot use them to raise resources when the cost of debt increases, and cannot use them to incentivize investment to improve the value of autarky.

Introducing utility default costs reduces the default incentives. In this case, the economy taxes more (on average) and taxes become more countercyclical than in the baseline economy. These results suggest that the government balances the costs of each way of expropriation over the business cycle. Abstracting from default would make the optimal taxation more countercyclical.

Finally, comparing the last two columns gives the impact of fixed taxes with low default incentives. In this case, the default frequency is smaller. The government loses one instrument and this reduces the value of autarky. Notice that this last column highlights the complementarity between these two types of expropriation, removing both of them reduces the default probability, the average spread, and its volatility to the lowest value of all the economies. Moreover, the cyclical features of the sovereign spread also fall (correlation with investment, output and government spending) to a minimum suggesting that the default probability that is reflected in the last column is independent of the macroeconomic environment and roughly exogenous.

The second block of the table shows the investment dynamics. Both taxes and default risk have a major impact on investment. Cyclical taxes reduce investment from 11 to 10 percent in terms of output. Default has a similar impact reducing it from 10.7 to 10 when default is an option. Both types of confiscation reduce investment: direct taxation (as taxes increase in bad times) has a reinforcing negative effect on investment returns. Additionally, default increases the cost of funds of the firms and this also reduces the investment return. Moreover, note that when we shut down taxes, investment becomes more procyclical. On the other hand, when we introduce the utility costs of default, taxes become more volatile and investment becomes less procyclical. These results highlight how tax volatility matters for investment by connecting the two expropriation risks.

The model overestimates the procyclicality of government spending. However, our decomposition allows us to understand its sources. Notice that when taxes are fixed, the procyclicality of spending decreases. With fixed taxes, the government wants to avoid default, and debt issuance falls. In good times, the government does not over-expand consumption to avoid accumulating debt.

The sovereign debt overhang

Our model reproduces the sovereign debt overhang effect documented in Sachs (1989), Krugman (1988) and also studied by Aguiar et al. (2009b), among others.

Table 6 presents the correlation, contemporaneous and at different lags, of the investment and the debt-to-output ratio. The model implies a negative correlation between investment and the debt-to-output ratio at all lags. In this way, the model reflects that a higher debt-to-output ratio is negatively correlated with investment. Nevertheless, the correlations do not allow us to understand the channels behind the negative relationship. To do so, we can directly analyze the first order conditions of the firm and the policy functions.

[Insert Table 6 here.]

Recall from the previous sections that we derived the FOC of the private firms with respect to the capital choice as

$$1 + C_1(k', \bar{k}) = E_{z'|z} M_{z'|z} \left[\alpha \left(\frac{\eta}{\bar{p}(\Theta r(z', \bar{k}', d'') + 1)} \right)^{\frac{\eta}{1-\eta}} (1-\tau') z'^{\frac{1}{1-\eta}} k'^{\frac{\alpha}{1-\eta}-1} + 1 - \delta \right].$$

On the left, we have the cost of one unit of capital. One unit of capital costs the firm one unit of final good and the marginal cost of installing it. The right-hand side is the expected return of capital priced using the households' stochastic discount factor. The equation captures that whether the firm invests or not, depends both on the return on capital and its valuation. The evolution of these two channels explains the dynamics of the sovereign debt overhang. First, anything that increases the expected profit taxes and the expected funding costs of the firm will decrease investment. The profit tax distorts the investment decision because they are collected from gross profits. Everything else equal, a higher debt-to-output ratio in the past, brings the economy closer to a debt crisis, with higher expected taxes and a higher probability of default that affects the firm through higher expected borrowing costs. Second, the stochastic discount factor depends on current and future marginal utilities of consumption and consumption depends on debt via taxes. Repaying a large debt today requires high taxes that reduce firms' distributed dividends and reduce consumption. As debt tends to be positively autocorrelated, it also implies high taxes and low consumption in the future. Hence, the behavior of the stochastic discount factor depends on the intertemporal allocation of taxes.

[Insert Figure 5 here.]

If we look directly at the policy functions, we can understand better the sources of this phenomenon. We plot them in Figure 5. The figure shows the policy functions of investment for different levels of the productivity shock. The first figure conditions on a higher level of capital while the second figure on a lower one. As expected, when the stock of capital is higher, all policy functions reflect a larger investment level. Additionally, investment is higher the higher the productivity level. What is less straightforward is that all policy functions exhibit the sovereign debt overhang effect. Investment decreases as the stock of debt of the government increases. The fall in investment is more pronounced for low levels of capital and productivity and accelerates as the stock of debt is larger.

We can also decompose the role of each source of each type of confiscation in the sovereign debt overhang effect. Figure 6 shows the investment policy function in the case of fixed taxes and in the case of utility default costs.

[Insert Figure 6 here.]

The figure shows that, in both cases, the debt overhang result disappears. The reason is the following: for the case in which corporate taxes are constant, an increase in debt in period t is not associated with higher taxation today or higher taxes in the future, as the government committed to a fixed tax. This reduces the role of debt both in the SDF and in the capital return channel. Moreover, as we saw in the previous section, the default probability for this calibration is nil as the government wants to avoid it as much as possible. This implies that there would be very low financial costs for the private sector in expected terms. Hence, higher debt today is not associated with lower expected investment returns.

In the case of the economy with utility costs of default, the channel operates mainly through the discount factor of the firms. In this context, there is no expected increase in the borrowing costs of the firms as default probability is virtually zero.

Second, debt has a larger impact on future consumption than on current consumption. As default is not an option in this case, postponing taxation has lower effects on the economy. This increases future expected marginal utility more than in the baseline. As the government is relatively impatient, it will try to postpone taxation implying that expected future consumption falls more than current consumption, effectively increasing the discount factor. The firm in this context has more incentives to invest, no less. This is why the investment policy functions are positively sloped for low to moderate debt levels. When default probability increases as debt becomes too large, the dynamics of the baseline kick in.

The effect through the stochastic discount factor operates in both cases but in the first case, it is partially compensated by the effect on the capital return. Instead, in the second case the expected change in taxes is not enough to compensate for the increase in patience.

Investment and the pricing of international debt

In our model, the stock of capital, even being privately owned in a competitive allocation, matters for the price of debt and, consequently, matters for the default incentives of the government. Figure 7 shows that the larger the stock of capital the lower the default incentives of the government, i.e. the higher the price of sovereign debt. Note that the government, when deciding optimal debt and default policies internalizes the impact of capital accumulation on default and the price of debt.

[Insert Figure 7 here.]

Why does higher capital contribute to a lower default probability? On the one hand, higher capital allows for more production and hence increases the tax base, which makes default less likely. Additionally, higher capital implies that in the event of default, default costs are also larger. In this model, the severity of default costs is endogenous and depends on the level of capital as it implies that the more capital you have the larger the foregone output in the case of default, so default becomes less likely. On the other hand, too much capital makes autarky a less painful state. For our calibration, we find that this second channel is quantitatively less important. Park (2017) discusses a hump-shaped relationship between spreads and capital stock in the context of a centralized capital accumulation decision.

The pricing effect is quantitatively important. Table 7 compares the baseline model with the one in which the international investors' pricing depends on a fixed level of capital rather than on the actual capital invested by the firm. The table shows that when the price effect is shut down, default is more frequent and the debt-to-output ratio is on average lower. Spreads also increase in level and volatility. Investment is a bit less volatile and procyclical.

[Insert Table 7 here.]

The impact of endogenous private capital operates through the pricing of international investors. When the stock of capital increases, the investors recognize there is a higher probability of repayment as the government's tax base increases.

[Insert Figure 8 here.]

Interestingly, the effect of capital on the pricing of debt has implications for the sovereign debt overhang effect. Figure 8 presents the policy functions for investment when the stock of capital in the pricing equation of investors is fixed. The figure looks similar to the baseline one, Figure 5. However, the sovereign debt overhang effect is ameliorated by the pricing of investors. The reduction in optimal investment is more dramatic when investors consider capital as fixed. As the spread increases more with debt when capital is fixed, this implies a larger sovereign debt overhang effect in this case. Hence, the pricing of investors affects investment, and investment also affects this price schedule.

5 Some considerations

This section considers two deviations from the baseline model that are worth studying to highlight the channels in our economy.

[Insert Table 8 here.]

The role of firms' discount

Through the stochastic discount factor (SDF), the firms take into account households' consumption. What role does it play and how does it relate to the government's choices? In general, the firms' discount factor coincides with the households' SDF because the households own the firms' stock and there is a market for trading equity. Hence, we can think about the model with a constant discount factor as one where domestic financial markets do not work well, i.e. a model with higher financial frictions. The comparison between the baseline and this alternative scenario is in Table 8, first two columns.

As the firms do not see their dividend policy affected by the relative marginal utilities of consumption, the market produces less consumption smoothing. The government's decisions are distorted. First, default frequency increases, and the government can sustain less debt in equilibrium. The government's default incentives increase to be able to help the households smooth consumption. On the other hand, optimal taxation becomes procyclical and incentivizes the firms to accumulate more capital in bad times to provide insurance to the households.

[Insert Figure 9 here.]

The SDF also matters for the sovereign debt overhang effect. Figure 9 shows the importance of the stochastic discount factor on this effect. The figure presents the policy function of investment as a function of the stock of debt, conditioning on the stock of capital and the level of productivity, for the baseline model and a model where the firms' discount factor is constant and equal to that of the households. Recall that the SDF is $\beta u'(c')/u'(c)$. The figure shows that the SDF amplifies the effect of the expected returns on the sovereign debt overhang effect. The reason is that higher debt levels imply lower current consumption which increases the marginal utility of consumption today and lowers the discount factor (they discount the future at a higher rate) of the firms. As discount factors are lower, the firms discount future dividends more and it is optimal to reduce investment. The same dynamics would hold in a model where the households own the stock of capital as they would directly internalize this effect.

Fixed stock of capital

One alternative to our model is a more standard one with a fixed capital stock. Table 8 presents the results for this case last column. With a fixed stock of capital, the government loses a powerful instrument. It cannot affect investment and firms' choices with optimal taxation. The government increases taxes in good times to provide more public goods, as they move closely with private consumption.

In the baseline the cyclicality of investment allows the government to sustain more debt in equilibrium. Note that when the optimal taxation affects the return to capital (through the SDF of firms), the taxes are countercyclical. The government does not find it optimal to increase taxes in the boom, capital is already increasing and higher taxes would decrease the return to capital. When capital is fixed, this effect disappears and the government increases the tax rates to provide more public goods to the households during the expansion.

The main difference between the two counterfactual exercises is that with constant SDF the default rate is 15% larger than with fixed capital as the government needs to do more consumption smoothing (that is not done by the firms' choice on their own). Besides this, an interesting result that is evident from Table 8 is that in both counterfactual economies, the dynamics look similar. In our quantitative model, the cyclicality and the variation of the SDF amplifies the impact of endogenous investment on the economy.

6 Final remarks

This paper discussed the importance of expropriation risk in the business cycle of Emerging countries. We designed a model where the government cannot commit to a level of taxes and cannot commit to debt repayment. The interaction of two sources of expropriation affects investment and, consequently, shapes the business cycle of Emerging countries prone to debt crisis. Using this model we can rationalize the low investment levels and its excess volatility. Moreover, the model produces a sovereign debt overhang effect and the paper shows the interplay between foreign investors pricing and capital accumulation. We find that the default probability affects the sovereign debt overhang effect, but also capital accumulation affects the pricing of sovereign debt and the likelihood of default.

References

Aguiar, M. and M. Amador (2011). Growth in the shadow of expropriation. *The Quarterly Journal of Economics 126*(2), 651–697.

Aguiar, M., M. Amador, and G. Gopinath (2009a). Expropriation dynamics. *American Economic Review 99*(2), 473–479.

Aguiar, M., M. Amador, and G. Gopinath (2009b). Investment cycles and sovereign debt overhang. *The Review of economic studies 76*(1), 1–31.

Arellano, C. (2008). Default risk and income fluctuations in emerging economies. *American economic review 98*(3), 690–712.

Arellano, C., Y. Bai, and L. Bocola (2017). Sovereign default risk and firm heterogeneity. Technical report, National Bureau of Economic Research.

Bai, Y. and J. Zhang (2012). Financial integration and international risk sharing. *Journal of International Economics 86*(1), 17–32.

Bianchi, J., J. C. Hatchondo, and L. Martinez (2018, September). International Reserves and Rollover Risk. *American Economic Review 108*(9), 2629–2670.

Chaumont, G., G. Melkadze, and I. Vardishvili (2023). Sovereign risk and economic activity: The role of firm entry and exit.

Cuadra, G., J. Sanchez, and H. Sapriza (2010, April). Fiscal Policy and Default Risk in Emerging Markets. *Review of Economic Dynamics 13*(2), 452–469.

Davis, J. S., M. B. Devereux, and C. Yu (2023). Sudden stops and optimal foreign exchange intervention. *Journal of International Economics*, 103728.

Dvorkin, M., J. M. Sánchez, H. Sapriza, and E. Yurdagul (2021, April). Sovereign Debt Restructurings. *American Economic Journal: Macroeconomics 13*(2), 26–77.

Eaton, J. and M. Gersovitz (1981). Debt with potential repudiation: Theoretical and empirical analysis. *The Review of Economic Studies 48*(2), 289–309.

Esquivel, C. (2022). Sovereign risk and dutch disease.

Gabaix, X. and M. Maggiori (2015). International liquidity and exchange rate dynamics. *The Quarterly Journal of Economics 130*(3), 1369–1420.

Galli, C. (2021). Self-fulfilling debt crises, fiscal policy and investment. *Journal of International Economics 131*, 103475.

Gonçalves, C. E. and B. Guimaraes (2015). Sovereign default risk and commitment for fiscal adjustment. *Journal of International Economics 95*(1), 68–82.

Gordon, G. and P. A. Guerron-Quintana (2018). Dynamics of investment, debt, and default. *Review of Economic Dynamics 28*, 71–95.

Kaas, L., J. Mellert, and A. Scholl (2020). Sovereign and private default risks over the business cycle. *Journal of International Economics 123*, 103293.

Krugman, P. (1988). Financing vs. forgiving a debt overhang. *Journal of development Economics 29*(3), 253–268.

Liu, S. and H. Shen (2022). Fiscal commitment and sovereign default risk. *Review of Economic Dynamics 46*, 98–123.

Mendoza, E. G. and V. Z. Yue (2012). A general equilibrium model of sovereign default and business cycles. *The Quarterly Journal of Economics 127*(2), 889–946.

Park, J. (2017). Sovereign default and capital accumulation. *Journal of International Economics 106*, 119–133.

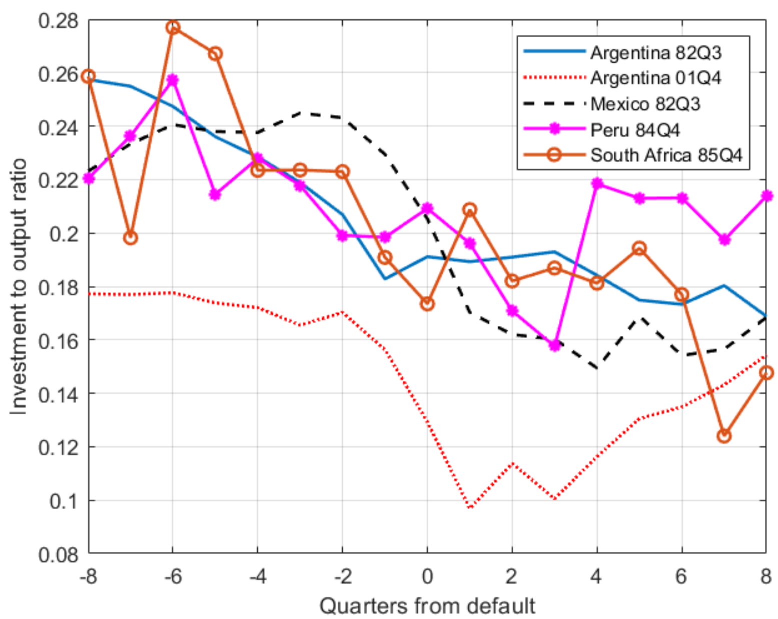
Sachs, J. (1989). The debt overhang of developing countries. debt stabilisation and development. g. calvo, r. findlay, p. kouri and jb d. macedo.

Table 1: Investment and Sovereign default

	Average $\frac{I}{Y}$	Average $\frac{I}{I_{-1}}$	Volatility $\frac{I}{I_{-1}}$
Emerging defaulters	20%	1.005	13%
Emerging non-defaulters	25%	1.007	11.4%
Emerging non-defaulters and Developed	23%	1.003	6.4%

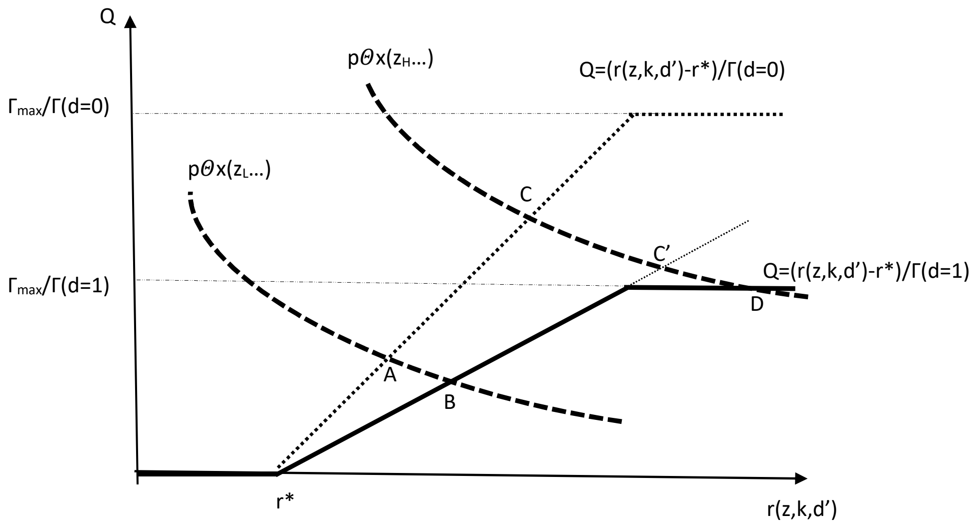
Note: The average and volatility of investment growth are computed using the log difference of consecutive quarters and are expressed at quarterly levels. Defaulters: Argentina, Bolivia, Brazil, Chile, Ecuador, Greece, Mexico, Peru, South Africa, Turkey and Uruguay. Emerging non-defaulters: Bulgaria, Colombia, Hong Kong, Hungary, Israel, Korea, Malaysia, Thailand. Developed: Australia, Austria, Belgium, Bulgaria, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, UK, US.

Figure 1: Investment to output ratio around default



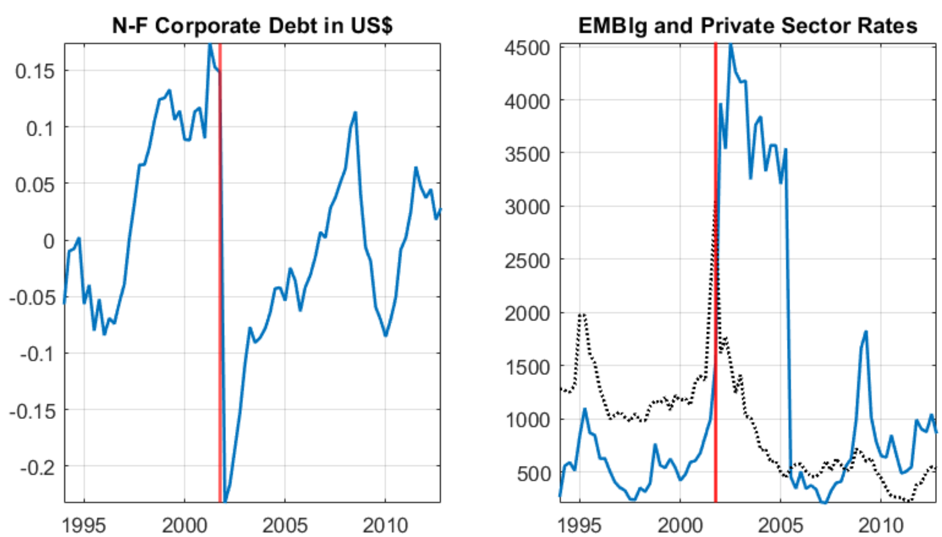
Note: The vertical axis shows the investment-to-output ratio. On the horizontal axis, we have the number of quarters before and after the sovereign default episode. The actual quarters of the sovereign default are indicated in the label to each line.

Figure 2: Demand and supply of corporate loans



Note: Equilibrium outcomes in the private sector financial market. The dashed lines represent credit demand for low and high TFP. The solid line in the credit supply when the government is in default. The dotted line is the credit supply when the government is in repayment status.

Figure 3: Corporate debt, Sovereign spreads and private sector lending rates



Note: Argentine data for EMBIG (blue solid line, in basis points) and private lending rates in USD (black dotted line, in basis points). Corporate rates data is from Kaas et al. (2020). N-F Corporate Debt denotes the debt of non-financial corporations and is measured as log-deviations with respect to its HP (1600) trend in USD. Data is from the BIS. The red vertical lines indicate the quarter in which sovereign default occurred.

Table 2: Parameters

Parameter	Value	Basis
Panel A: Outside the model		
γ	2	Standard value in the RBC literature
δ	0.02	Standard
β	0.96	Standard
r^*	0.017	Arellano (2008)
θ	0.282	Arellano (2008)
ψ	0.2	Dvorkin et al. (2021)
α	0.17	Mendoza and Yue (2012)
η	0.43	Mendoza and Yue (2012)
Panel B: Calibrated		
κ	7	$\sigma(i)/\sigma(y)$
μ	1.78	Public expenditure - output ratio
ν	0.07	$\sigma(g)/\sigma(y)$
ρ_z	0.82	Autocorr. output
σ_z	0.035	Sd. output
Γ_L	0.074	Avg. corporate spread
Γ_H	0.192	Drop in output at default
Γ_{max}	0.038	Def. rate 2% per year

Table 3: Targeted moments

Moment	Data	Model
$\sigma(i)/\sigma(y)$	2.45	2.63
Public expenditure - output ratio	0.13	0.14
$\sigma(g)/\sigma(y)$	1.11	1.11
Autocorr. output	0.84	0.84
Sd. output	0.10	0.11
Avg. corporate spread	0.085	0.088
Drop in output at default	0.15	0.13
Default rate (%)	2.0	1.9

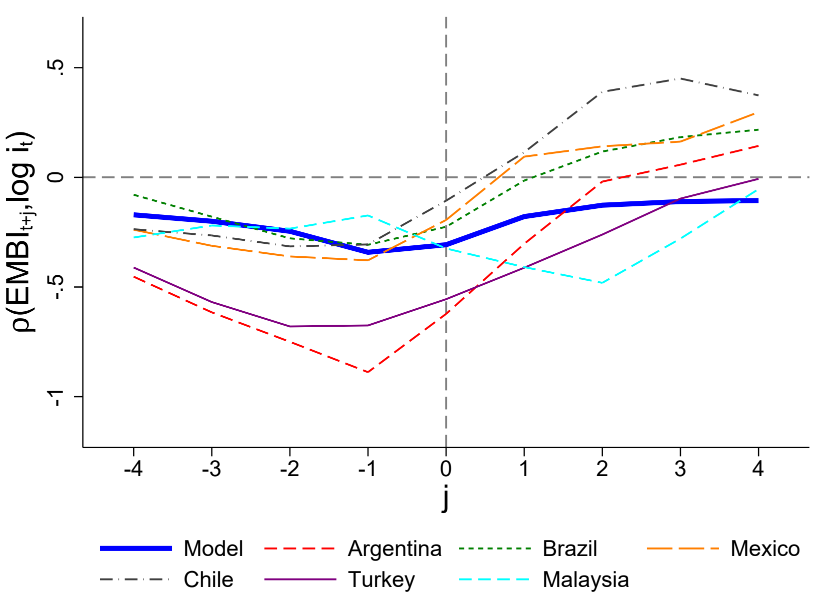
Notes: The data statistics are based on Argentina. All moments were computed with log-detrended data with HP(1600). Moments are at quarterly levels unless noted otherwise. Debt to output ratio is General government gross debt, Percent of GDP, Annual, not seasonally adjusted, from the Federal Reserve Bank of St. Louis period 1992-2019 (GGGDTAARA188N). Corr. stock market-private debt is computed for pre-default data. The correlation of EMBI with investment excludes the periods during default. The default rate is annualized.

Table 4: Non-targeted moments

Moment	Data	Model
National account variables		
$\sigma(c)/\sigma(y)$	1.29	1.00
$E(i/y)\%$	20.0	10.0
$\rho(i,y)$	0.92	0.66
$\sigma(tb/y)/\sigma(y)$	0.51	0.40
$\rho(c,y)$	0.91	0.97
$\rho(tb/y,y)$	-0.39	-0.10
$\rho(g,y)$	0.54	0.93
Spreads excluding default episodes		
$E(EMBI)$	6.0	0.4
$\sigma(EMBI)$	4.9	0.84
$\rho(EMBI,y)$	-0.62	-0.41
$\rho(g,EMBI)$	0.08	-0.44
Spreads including default episodes		
$E(EMBI)$	14.1	3.3
$\sigma(EMBI)$	18.4	16.4
$\rho(EMBI,y)$	-0.65	-0.23
$\rho(g,EMBI)$	-0.67	-0.26

Notes: The data statistics are based on Argentina. Government expenditure volatility and average share are taken from Kaas et al. (2020). Argentinean data is from 1994Q1-2012Q4. The correlations with EMBI in the data that excludes default periods is the average of the correlations pre and post-default episodes. In the data, EMBIg is measured in annualized terms. Average spread and volatility of spreads are in %.

Figure 4: Dynamic correlations investment-sovereign spreads



Note: In the horizontal axis we have the lags and leads of the $EMBI$ that denotes the JP Morgan EMBIG index for each economy. Investment is the gross capital formation of the private sector at constant local currency in log deviations with the HP trend. We provide details of the model simulation procedure in the appendix.

Table 5: Decomposing time inconsistency

Moment	Baseline	Fixed tax	U cost of d	Fixed tax + U cost
Default rate	1.9	0.4	0.4	0.2
$E(b/y)$	-13.3	-11.2	-43.8	-33.6
$E(EMBI)$	0.4	0.08	0.08	0.01
$\sigma(EMBI)$	0.8	0.36	0.2	0.03
$\rho(EMBI, y)$	-0.4	-0.3	-0.4	-0.1
$E(i/y)\%$	10.0	11.0	10.7	10.7
$\sigma(i)/\sigma(y)$	2.6	1.35	2.8	2.4
$\rho(i, y)$	0.66	0.99	0.64	0.99
$\rho(i, EMBI)$	-0.31	-0.34	-0.20	-0.12
$\sigma(g)/\sigma(y)$	1.1	1.3	1.1	1.2
$\rho(g, y)$	0.97	0.79	0.97	0.99
$\rho(g, EMBI)$	-0.44	-0.35	-0.39	-0.14
$E(\tau)$	15.1	15.0	16.8	16.8
$\sigma(\tau)$	3.9		4.0	
$\rho(\tau, y)$	-0.09		-0.17	

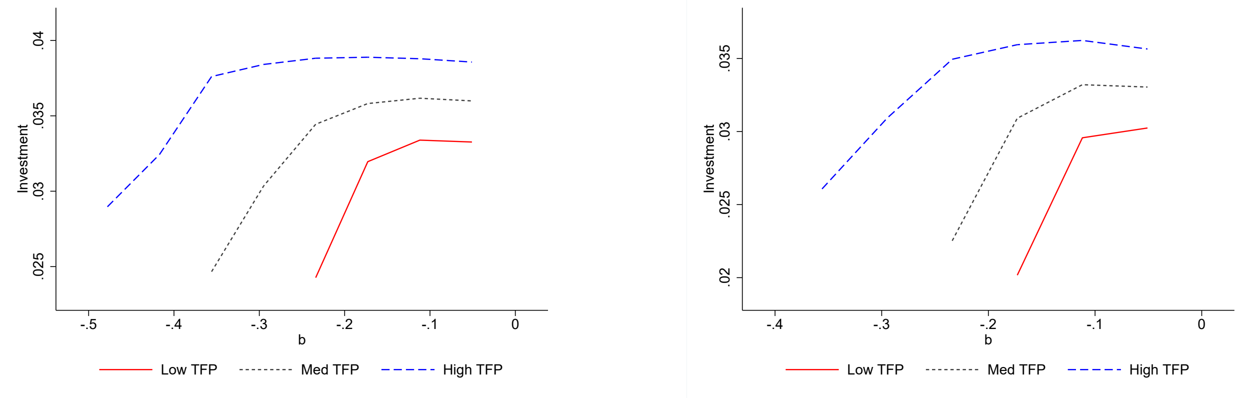
Note: We provide details of the model simulation procedure in the appendix.

Table 6: Investment and sovereign debt

Moment	Baseline
$\rho(i, b/y)$	-0.28
$\rho(i, L(b/y))$	-0.22
$\rho(i, L^4(b/y))$	-0.12
$\rho(i, L^8(b/y))$	-0.07

Note: L denotes lagged value, L^4 is lagged 4 quarters, L^8 denotes lagged 8 quarters and F denotes one period forward. We provide details of the model simulation procedure in the appendix.

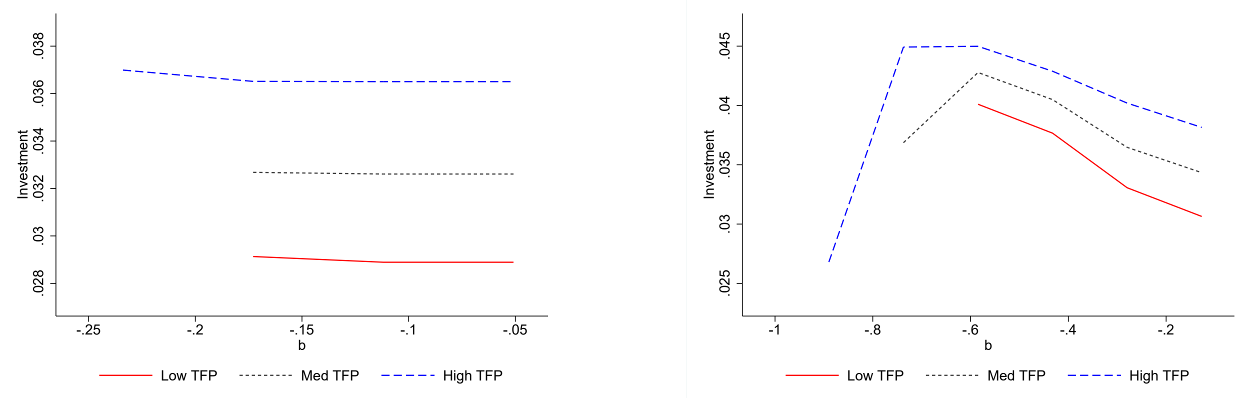
Figure 5: Investment policy functions



(a) High level of capital

(b) Low level of capital

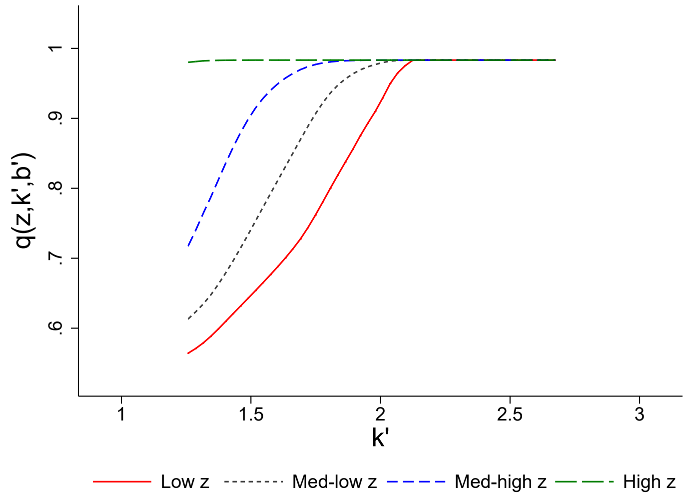
Figure 6: Investment policy functions in counterfactuals



(a) Fix taxes

(b) Utility costs

Figure 7: Debt price and capital



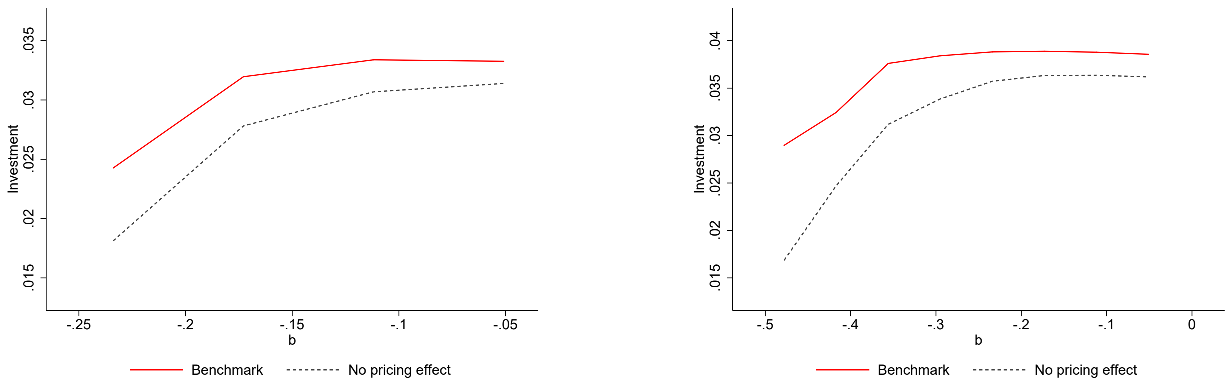
Note: The figure plots the debt price function $q(z, \bar{k}', b')$ for mean debt level with levels of productivity, z equal to 0.92, 0.95, 1 (mean) and 1.09.

Table 7: The pricing effect

Moment	**Baseline**	**No pricing effect**
Default rate	1.9	2.9
$E(b/y)$	-13.3	-12.8
$E(EMBI)$	0.4	1.06
$\sigma(EMBI)$	0.8	2.4
$\sigma(i)/\sigma(y)$	2.63	2.35
$\rho(i, y)$	0.66	0.58

Note: We provide details of the model simulation procedure in the appendix.

Figure 8: Investment, role of the pricing effect



(a) Low TFP

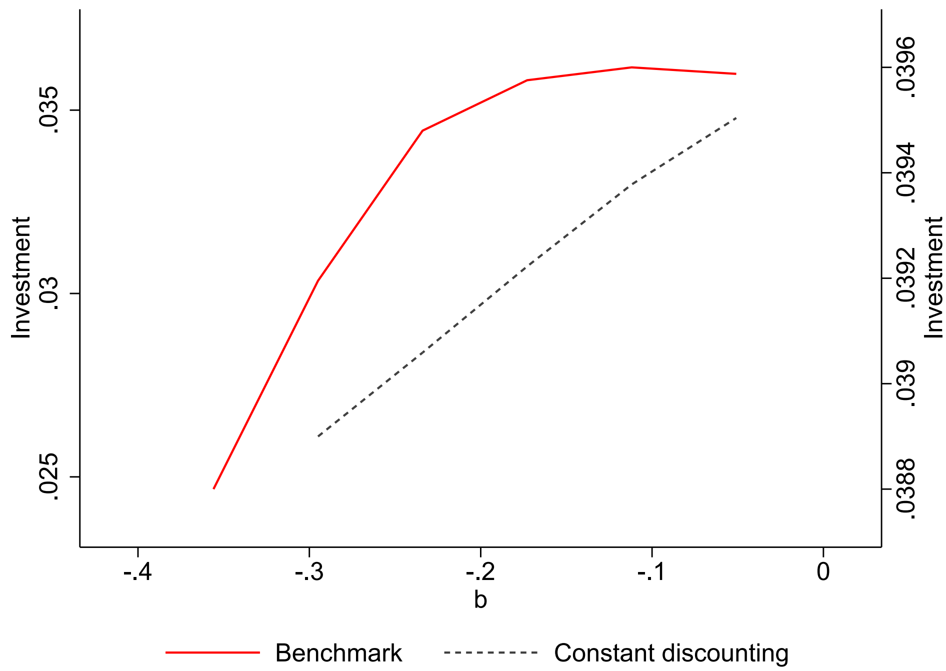
(b) High TFP

Table 8: Robustness analysis

Moment	**Baseline**	**Constant disc. factor (firms)**	**Fixed capital**
Def. rate	1.86	2.33	2.00
$E(b/y)$	-13.26	-10.37	-10.08
$\sigma(c)/\sigma(y)$	1.00	1.05	1.07
$\rho(\tau, y)$	-0.09	0.34	0.35
$\rho(i, y)$	0.66	0.97	
$\rho(i, -b/y)$	-0.28	-0.80	
$\rho(i, EMBI)$	-0.31	-0.54	

Notes: We provide details of the model simulation procedure in the appendix.

Figure 9: Investment's policy functions and the discount factor



A Online Appendix

A.1 Computational details

Solution of the model. We solve the model with a discrete debt grid of 61 points, a capital grid of 50 points, and a productivity grid of 41.[7] We introduce taste shocks as in Dvorkin et al. (2021) to smooth out the problem of the government and facilitate convergence. In a nutshell, this means that the government draws a random vector of taste shocks each period, with $N+1$ components, where N is the number of possible discrete debt choices and $+1$ corresponds to the additional discrete choice of default. Each component of this vector shifts the value of a different discrete choice (debt level and default). Formally, the problem of the government in the model with the taste shocks is:

$$V(z, \bar{k}, b_i; \epsilon) = \max\{V^C(z, \bar{k}, b_i; \epsilon), V^D(z, \bar{k}, b; \epsilon_{J+1})\}.$$

[7] Doubling the sizes of the grids does not change significantly the results presented in this paper.

The value for the case of repayment is:

$$V^C(z,\bar{k},b_i;\epsilon) = \max_{g,b_k,\tau} \; u(c) + v(g) + \epsilon_k + \beta_h E_{z'|z} E_{\epsilon'} \Big[V(z',\bar{k}',b_k;\epsilon') \Big]$$

subject to

$$g = q(z,\bar{k}',b_k)b_k - b_i + \tau \left(zf(\bar{k},x) - \bar{p}x(\Theta r(z,\bar{k},0)+1) \right)$$

$$c = (1-\tau) \left(zf(\bar{k},x) - \bar{p}x(\Theta r(z,\bar{k},0)+1) \right) - \bar{k}' + \bar{k}(1-\delta) - C(\bar{k}',\bar{k})$$

$$\bar{k}' = k^*(z,\bar{k};b_k,0)$$

$$x = x^*(z,\bar{k},0).$$

The value when the government is in default is:

$$\begin{aligned} V^D(z,\bar{k},b_i;\epsilon_{J+1}) \;\; = \;\; & \max_{g,\tau} \; u(c) + v(g) + \epsilon_{J+1} \\ & + \beta_h E_{z'|z} E_{\epsilon'} \Big[\theta V(z',\bar{k}',(1-\psi)b_i;\epsilon') + (1-\theta) V^D(z',\bar{k}',b_i;\epsilon'_{J+1}) \Big] \end{aligned}$$

subject to

$$\begin{aligned} & g = \tau \left(zf(\bar{k},x) - \bar{p}x(\Theta r(z,\bar{k},1)+1) \right) \\ & c = (1-\tau) \left(zf(\bar{k},x) - \bar{p}x(\Theta r(z,\bar{k},1)+1) \right) - \bar{k}' + \bar{k}(1-\delta) - C(\bar{k}',\bar{k}) \\ & \bar{k}' = k^*(z,\bar{k};b_i,1) \\ & x = x^*(z,\bar{k},1), \end{aligned}$$

In this model, we denote the policy functions, after the realization of the taste shocks, of the government for optimal debt as $\tilde{b}(z,\bar{k},b_i,d;\epsilon)$, for default as $\tilde{d}(z,\bar{k},b_i,d;\epsilon)$, and for the profit tax as $\tilde{T}(z,\bar{k},b_i,d;\epsilon)$. By construction, these policy functions for debt and default ex-post are discrete functions, that take the form of the optimal debt grid and the default choice given the taste vector ϵ.

The zero-profit condition for the debt in good standing becomes:

$$q(z,\bar{k}',b_k) = \frac{1}{1+r^*}\mathbb{E}_{z'|z}\mathbb{E}_{\epsilon'}\left\{1-\tilde{d}(z',\bar{k}',b_k;\epsilon')+\tilde{d}(z',\bar{k}',b_k;\epsilon')q^D(z',\bar{k}'',b_k)\right\},$$

where $\bar{k}'' = k^*(z',\bar{k}';b_k,1)$. The same condition for the debt in default is:

$$q^D(z,\bar{k}',b_k) = \theta(1-\psi)q(z,\bar{k}',(1-\psi)b_k) + \frac{1-\theta}{1+r^*}\mathbb{E}_{z'|z}\left\{q^D(z',\bar{k}'',b_k)\right\},$$

As shown in Dvorkin et al. (2021), the policy functions of the government for the discrete choices can be thought of as probabilities before the realization of the taste shocks: $\tilde{\mathbf{b}}_k(z,\bar{k},b_i,d)$ would denote the probability of choosing debt grid k in case of not defaulting, and $\tilde{\mathbf{d}}(z,\bar{k},b_i,d) = E_\epsilon \tilde{d}(z,\bar{k},b_i,d;\epsilon)$ would denote the probability of defaulting given your other states. With this notation in hand, we can rewrite the price function for the debt in good standing as:

$$q(z,\bar{k}',b_k) = \frac{1}{1+r^*}\mathbb{E}_{z'|z}\left\{1-\tilde{\mathbf{d}}(z',\bar{k}',b_k)+\tilde{\mathbf{d}}(z',\bar{k}',b_k)q^D(z',\bar{k}'',b_k)\right\}$$

for the debt in default. We also follow Dvorkin et al. (2021) in assuming that the ϵ vector follows a Generalized Extreme Value distribution, represented by:

$$G(\epsilon) = \exp\left[-\left(\sum_{j=1}^{J}\exp\left(-\frac{\epsilon_j}{\sigma}\right)\right)-\exp\left(-\frac{\epsilon_{J+1}}{\sigma}\right)\right].$$

This functional assumption implies a particular analytical formula for the ex-ante policy functions $\tilde{\mathbf{d}}(z,\bar{k},b_i,d)$ and $\tilde{\mathbf{b}}(z,\bar{k},b_i,d)$ in terms of the values obtained in each discrete choice relative to a non-linear aggregation of the values obtained by each discrete choice, for which we refer the reader to the original paper. We set the volatility of these shocks, σ to 0.01. This value is high enough to facilitate convergence, but small enough to not have a significant impact in the moments of interest (as implied by, for instance, doubling the size of the shocks).

Simulation details. To produce model moments and dynamics we run 3000 simulations of the model for 400 periods and we discard the first 100 periods. We take into account all the data for all the variables except for the sovereign spreads, for which we discard the periods that the economy is in default.